The Journal of Basic & Applied Zoology (2012) **65**, 21–28

The Egyptian German Society for Zoology

The Journal of Basic & Applied Zoology

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Effect of intercropping of maize, bean, cabbage and toxicants on the population levels of some insect pests and associated predators in sugar beet plantations

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Received 21 January 2012; accepted 18 February 2012
Available online 27 August 2012

KEYWORDS

Intercropping;
Sugar beet plantations;
Insect pest population density;
Sugar beet predators;
Toxicants

Abstract Experiments were carried out at El-Riad district, Kafr El-Sheikh Governorate in two successive growing seasons (2009/10 and 2010/11) to study the effect of intercropping of faba bean, maize and cabbage with sugar beet on the population density of *Empoasca* spp. (nymphs and adults), *Aphis* spp. (nymphs and adults), *Bemisia tabaci* (adults), *Pegomyia mixta* (eggs and larvae), *Cassida vittata* (larvae, pupae and adults) and predators in sugar beet plantations compared with the non-intercropped plants and the resulting yield. The toxicity of certain compounds: fenitrothion, super misrona, sour orange oil, acidless orange oil, and Bermectine in reducing the population density of *P. mixta* and *C. vittata* larvae infesting sugar beet was evaluated. The rate of infestation was higher in the sole sugar beet plants than in those intercropped with faba bean, maize and cabbage plants which caused reduction of sucking pests and *P. mixta* eggs in the two seasons. The intercropping of faba bean plants led to higher infestation rate of *P. mixta* larvae in the two seasons and *C. vittata* (larvae, pupae and adults) in the first season. The intercropping with maize led to a higher population density of *Chrysoperla carnea*, *Paederus alfierii* and *Scymnus* spp. in the two seasons. Low population density of true spiders was observed in sole sugar beet (control) when compared with faba bean, maize and cabbage plants intercropped in the two seasons. Concerning the obtained root yield, the intercropping with maize and cabbage plants reduced the resultant yield of sugar beet roots in the two seasons. Bermectine and fenitrothion were the most effective toxicants followed by super misrona and then, sour orange that induced the lowest reduction in *P. mixta* larvae. Also, fenitrothion and Bermectine were the most potent compounds in reducing the population density of *C. vittata* larvae followed by super misrona and then, plant oil extracts. Concerning the side effects of these compounds on predators, sour orange oil and acidless orange oil had slight effects, whereas Bermectine and super misrona caused a

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Peer review under responsibility of The Egyptian German Society for Zoology.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.jobaz.2012.02.002

moderate effect against predators. However, fenitrothion was the most highest toxic compound against predators.

Introduction

For many years, chemical insecticides have been used in a large and unwise scale for controlling agricultural pests. The increasing resistance of pests against chemical pesticides, pollution of the ecosystem and other deleterious side effects on non-target organisms have initiated and favored the use of other agents to be incorporated into integrated control programs.

The intercropping between the different crops and its effect on the occurrence of the pests is recommended in some cases as one of agricultural practices and of integrated pest management (IPM) elements. So many authors studied its positive and negative effects on the infestation rates of the pests. For example, Bregante and Matta (1985) studied the intercropping of maize and *Phaseolus vulgaris*. Omar et al. (1993) in Egypt, conducted field trails to study the effect of two intercropping systems of cotton and cowpea on the population density of target pests, aphids, jassid, whitefly, *T. arabicus* and bollworm. Also, Omar et al. (1994) reported that intercropping of cowpea with cotton as a cultural method to decrease target pests of cotton. Kucharczyk and Legutowska (2001), Trdan et al. (2006) and Metwally et al. (2008) performed the effect of different intercropping systems between plants on pest populations and weight of yield. Hassan (2009) found that cowpea + sorghum intercrop reduced aphid (*Aphis craccivora*) population significantly compared to sole cowpea crop in Mubi, Adamawa State, Nigeria. Oso and Falade (2010) pointed that intercropping may not necessarily reduce pest load in any given situation.

A wide range of chemicals have been marketed for controlling pests, but their intensive use resulted in many problems. Alternatively, non-chemical control methods have been widely assessed, and the most successful ones are the exploitation of predators (Saied et al., 2002; Mahmoud and Osman, 2007). Omar et al. (2001) found that the most harmful insecticide on *Coccinella undecimpunctata* L., *Chrysoperla carnea*, Step. and *Orius albidipennis* Reut. was malathion which significantly reduced the numbers of predators especially in plots treated three times on squash plants. El Fakharany (2005) found that fenitrothion was the most harmful on predators; *Scymmus* spp., *C. undecimpunctata*, *Orius* sp., *S. corollae* and true spiders. Kz oil was of a moderate effect, while sour orange oil and acidless orange oil were the safest tested compounds on all predators on watermelon and pepper plants. El Fakharany (2010) found that Marshal induced moderate effect while Bermectine exhibited a slight effect against *C. carnea* and true spiders in cabbage plants.

The present study aims to investigate the effect of intercropping system between sugar beet plants and faba bean, maize and cabbage plants on pest populations infesting leaves of sugar beet plants, the predators under field conditions and the final yield of sugar beet. Also, efficiencies of certain compounds; fenitrothion, Bermectine, super misrona, sour orange oil and acidless orange oil in reducing the population density of *Pegomyia mixta* and *Cassida vittata* infesting sugar beet plants and their side effects on predators were evaluated.

Materials and methods

Population fluctuation of pests and their predators in sugar beet plantations

For studying the effect of intercropping system of faba bean, maize and cabbage plants on the abundance of some pests infesting sugar beet plants, a field experiment was conducted at El-Riad district, Kafr El-Sheikh Governorate during the sugar beet growing 2009/10 and 2010/11 seasons. The sugar beet cultivar, Monte Bianco was chosen as the major crop with faba bean (*Vicia faba* L.), maize (*Zea mays* L.) and cabbage (*Brassica oleracea* var. *capitata* Linneu). The experimental area was about one feddan divided into four plots, each treatment was represented by three replicates arranged in a complete randomized block design. The seeds of faba bean and maize crop were planted in the middle of row and sugar beets were planted on the two sides of the rows in the two growing seasons on September 20th and after 10 days on 30th September cabbage seedlings were transplanted into one side of row.

Population fluctuations of *Empoasca* spp. (nymphs and adults), *Aphis* spp. (nymphs and adults), *Bemisia tabaci* Genn. (adults), *P. mixta* Vill. (eggs and larvae), *C. vittata* Vill. (larvae, pupae and adults) and predators [*C. carnea* Stephens (eggs, larvae and adults), *Paederus alfierii* Koch (adults), *Scymnus* spp. (larvae and adults) and spiders (spiderling and adults)] were investigated. Inspection started 30 days after sowing, and continued biweekly till the end of the crop season. Numbers of pests and predators were counted on 10 plants/replicate in the field.

Effect of intercropping on sugar beet net root weight production

Impact of the used intercropping on the weight of the final crop production (roots) was evaluated. Sugar beet final total yield (roots) was taken from one plot (1 m^2) and repeated 3 times for each treatment.

Toxicity of the tested compounds against P. mixta and C. vittata larvae

Toxicological studies were carried out in a field of sugar beet (one half feddan) at El-Riad district, Kafr El-Sheikh Governorate during 2009/10 and 2010/11 seasons. The tested compounds were applied at recommended doses using a knapsack sprayer with one nozzle. These compounds were sprayed on March 16th (2009/10) and November 17th (2010/11) for *P. mixta* and on March 16th in both the seasons for *C. vittata*. The tested compounds and rate per 100 l water were as follows:

A. *Pesticide:* Fenitrothion (Sumithion) 50% EC at 375 ml/100 l water.
B. *Biopesticides:* Abamectin (Bermectine) 1.8% EC at 40 ml/100 l water.
C. *Mineral oil:* Super misrona 94% EC at 1.5 l/100 l water.
D. *Plant oil extracts:*
1 Sour orange (*Citrus aurantium* L.) at rate 1.5 l/100 l water.
2 Acidless orange (*Citrus sinensis* Osbek) at rate 1.5 l/100 l water.

Counts of *P. mixta* and *C. vittata* (larvae) were recorded before spraying on 30 sugar beet plants (10/replicate). Counts were also recorded on 1, 3, 5, 7, 10 and 14 days after application for *C. vittata* and predators. While counts were recorded on 3, 5, 7, 10 and 14 days after application for *P. mixta* larvae and predators. Percentage of reduction was calculated according to Henderson and Telton (1955) equation.

Results and discussion

Pests

The effect of intercropping system of sugar beet cultivar, Monte Bianco as the major crop with faba bean, maize and cabbage as the minor crops on the level of infestation of *Empoasca* spp. (nymphs and adults), *Aphis* spp. (nymphs and adults), *B. tabaci* (adults), *P. mixta* (eggs and larvae) and *C. vittata* (larvae, pupae and adults) during 2009/10 and 2010/11 seasons are presented in Tables 1 and 2 with their statistical analysis.

Intercropping significantly reduced *Empoasca* spp. population in the two seasons with the population being consistently lower in cabbage + sugar beet, maize + sugar beet and faba bean + sugar beet intercrop than in sole sugar beet crop (Table 1).

The rate of infestation was higher on the sole sugar beet plants than on those intercropped with faba bean, maize and cabbage plants which caused reduction of the population of *Aphis* spp. on the sugar beet plants in the two seasons (Table 1). The results of the present study agree with those obtained by other authors that intercropping has the potential to reduce aphid population. For instance, Sinthananthem et al. (1990) and Ogenga-Latigo et al. (1992) reported that intercropping cowpea with maize reduced the incidence of *Aphis fabae* on cowpea than on sole cropped cowpea. Nampala et al. (2002) reported that mixed cropping of cowpea with sorghum reduced infestation by aphids. Hassan (2009) found that cowpea + sorghum intercrop reduced aphid (*Aphis craccivora* Koch.) population significantly compared to sole cowpea crop in Mubi Adamawa State, Nigeria.

Similarly, maize + sugar beet, faba bean + sugar beet and cabbage + sugar beet intercrop reduced whitefly population significantly compared to sole sugar crop in the two seasons (Table 1).

The rate of infestation was higher on the sole sugar beet plants than on those intercropped with faba bean, cabbage and maize plants which caused reduction of the population of *P. mixta* eggs on the sugar beet leaves in both the seasons (Table 2). However, population of *P. mixta* larvae was lower in cabbage + sugar beet, maize + sugar beet and sole sugar beet, than faba bean + sugar beet intercrop (Table 2).

The rate of infestation was higher on faba bean + sugar beet and the sole sugar beet plants than on those intercropped with cabbage + sugar beet and maize + sugar beet plant which caused reduction of the population of *C. vittata* larvae on the sugar beet plants (Table 2). During 2009/10 season, *C. vittata* pupae population was lower in cabbage + sugar beet and maize + sugar beet intercrop than in faba bean + sugar beet and sole sugar beet while the difference between the treatments was significant in 2010/11 season (Table 2). During 2009/10 season, the same pattern of infestation levels of *C. vittata* adults to sugar beet plants in the three used intercropping system compared with the level of infestation in the control treatment was obtained (Table 2). The rates of infestation were higher in sugar beet + faba bean than in those intercropped with sole sugar beet, cabbage and maize. In 2010/11 season, they were being insignificantly different from each other but significantly differ from those planted with faba bean crop.

Table 1 Potency of intercropping of some crops with sugar beet on the population density of sucking pests compared with the solely sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate.

Treatment	Season	Seasonal mean ± standard error		
		Empoasca spp.	*Aphis* spp.	*Bemisia tabaci*
Faba bean + sugar beet	2009/10	$25.89^{b} \pm 6.19$	$1.83^{b} \pm 1.33$	$0.55^{c} \pm 0.34$
Maize + sugar beet		$23.00^{b} \pm 5.43$	$0.50^{d} \pm 0.25$	$0.50^{d} \pm 0.31$
Cabbage + sugar beet		$15.88^{c} \pm 3.54$	$0.98^{c} \pm 0.56$	$0.81^{b} \pm 0.58$
Control (sugar beet)		$38.01^{a} \pm 7.81$	$3.21^{a} \pm 1.64$	$1.55^{a} \pm 1.03$
F		437.11^{**}	126.93^{**}	2346.92^{**}
LSD 5%		1.51	0.345	0.033
Faba bean + sugar beet	2010/11	$24.64^{b} \pm 9.66$	$0.71^{b} \pm 0.29$	$0.79^{c} \pm 0.30$
Maize + sugar beet		$21.83^{c} \pm 7.66$	$0.71^{b} \pm 0.32$	$0.67^{d} \pm 0.31$
Cabbage + sugar beet		$15.83^{d} \pm 6.00$	$0.50^{c} \pm 0.19$	$1.00^{b} \pm 0.42$
Control (sugar beet)		$28.29^{a} \pm 10.04$	$1.41^{a} \pm 0.47$	$1.79^{a} \pm 0.54$
F		150.57^{**}	165.44^{**}	3051.20^{**}
LSD 5%		1.390	0.142	0.030

In column means followed by same letter are not significantly different at the 5% level by DMRT (1955).
* Significant.
** Highly significant.

Table 2 Potency of intercropping of some crops with sugar beet on the population density of *Pegomyia mixta* and *Cassida vittata* compared with the solely sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate.

Treatment	Season	Seasonal mean ± standard error				
		Pegomyia mixta		*Cassida vittata*		
		Eggs	Larvae	Larvae	Pupae	Adults
Faba bean + sugar beet	2009/10	$7.83^{b} \pm 1.68$	$0.88^{a} \pm 0.25$	$25.79^{a} \pm 14.77$	$2.71^{ab} \pm 1.54$	$1.79^{a} \pm 0.86$
Maize + sugar beet		$6.48^{d} \pm 1.99$	$0.74^{c} \pm 0.25$	$17.02^{c} \pm 12.13$	$2.50^{b} \pm 1.63$	$1.02^{d} \pm 0.65$
Cabbage + sugar beet		$7.38^{c} \pm 2.11$	$0.62^{d} \pm 0.22$	$22.29^{b} \pm 13.23$	$2.00^{c} \pm 1.25$	$1.14^{c} \pm 0.85$
Control (sugar beet)		$8.36^{a} \pm 1.77$	$0.81^{b} \pm 0.29$	$25.10^{a} \pm 14.26$	$2.83^{a} \pm 1.65$	$1.60^{b} \pm 0.85$
F		219.96**	84.79**	161.56**	17.58**	110.92**
LSD 5%		0.175	0.041	1.023	0.285	0.113
Faba bean + sugar beet	2010/11	$6.05^{b} \pm 3.32$	$1.36^{a} \pm 0.38$	$17.29^{a} \pm 9.68$	$1.76^{b} \pm 1.02$	$0.88^{b} \pm 0.50$
Maize + sugar beet		$5.67^{c} \pm 2.74$	$1.05^{c} \pm 0.31$	$14.79^{b} \pm 8.60$	$1.55^{c} \pm 1.01$	$1.10^{a} \pm 0.58$
Cabbage + sugar beet		$5.83^{bc} \pm 2.70$	$0.74^{d} \pm 0.16$	$15.10^{b} \pm 9.04$	$1.43^{d} \pm 0.93$	$1.00^{a} \pm 0.48$
Control (sugar beet)		$7.00^{a} \pm 3.39$	$1.19^{b} \pm 0.34$	$16.50^{a} \pm 9.62$	$2.14^{a} \pm 1.35$	$1.00^{a} \pm 0.48$
F		66.65**	60.17**	14.01**	135.35**	6.60**
LSD 5%		0.238	0.111	1.028	0.087	0.109

In column means followed by same letter are not significantly different at the 5% level by DMRT (1955).
* Significant.
** highly significant.

Table 3 Potency of intercropping of some crops with sugar beet on the population density of predators compared with the solely sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate.

Treatment	Season	Seasonal mean ± standard error			
		Chrysoperla carnea	*Paederus alfierii*	*Scymnus* spp.	True spiders
Faba bean + sugar beet	2009/10	$0.98^{c} \pm 0.39$	$0.24^{b} \pm 0.10$	$0.19^{c} \pm 0.09$	5.98a ± 1.41
Maize + sugar beet		$1.64^{a} \pm 0.36$	$0.31^{a} \pm 0.17$	$0.33^{a} \pm 0.16$	5.19b ± 0.74
Cabbage + sugar beet		$1.26^{b} \pm 0.33$	$0.12^{c} \pm 0.06$	$0.14^{d} \pm 0.07$	5.29b ± 0.77
Control (sugar beet)		$0.43^{d} \pm 0.43$	$0.31^{a} \pm 0.16$	$0.24^{b} \pm 0.10$	4.38c ± 0.74
F		399.22**	137.71**	78.80**	50.04**
LSD 5%		0.083	0.025	0.030	0.302
Faba bean + sugar beet	2010/11	0.62b ± 0.28	0.21b ± 0.09	0.22b ± 0.08	8.02ab ± 2.57
Maize + sugar beet		0.88a ± 0.39	0.36a ± 0.15	0.26a ± 0.13	8.12a ± 2.35
Cabbage + sugar beet		0.64b ± 0.27	0.21b ± 0.10	0.22b ± 0.08	7.52bc ± 2.52
Control (sugar beet)		0.55b ± 0.25	0.38a ± 0.18	0.19b ± 0.08	7.31c ± 2.34
F		25.78**	29.67**	9.90**	6.00**
LSD 5%		0.092	0.054	0.030	0.519

In column means followed by same letter are not significantly different at the 5% level by DMRT (1955).
* Significant.
** Highly significant.

Predators

Data recorded in Table 3 indicate that sugar beet plants intercropped with maize yielded the highest population density of *C. carnea* in the two seasons, compared with either control (sugar beet only) or any intercropping system tested. The same pattern was also obtained for the population density of *P. alfierii* and *Scymnus* spp. However, the difference between the mean population density of *P. alfierii* at maize + sugar beet and control was insignificant (Table 3).

Higher population density of true spiders was observed with faba bean, maize and cabbage intercrop in the two seasons compared with sole sugar beet (control) (Table 3).

Root yield

During 2009/10 and 2010/11, the resultant yield, due to intercropping, was also affected. When compared with control the sugar beet plants intercropped with faba bean gave the highest root yield. In the contrary, the intercropping with maize and cabbage plants reduced the resultant yield of sugar beet roots in the two seasons (Table 4). These results are concomitant with the results obtained in Tables 1 and 2, as intercropping of sugar beet with faba bean resulted in the least population density of pests infesting sugar beet plants and the vice versa with intercropping either maize or cabbage with sugar beet.

Parsons (2003) found that intercrop cane should seriously consider planting the intercrop in alternate cane inter rows with cabbage, maize and sometimes other crops which will reduce costs and the competitive effect on the cane yield, but still produce a useful profit from the food crop. These are planted in sole stand and are significant for the small scale grower, who will increase the profitability by intercropping his/her vegetables rather than cultivating them on a separate piece of land. Raji (2007) found that intercropping soybean and maize on flat reduced yields by 13.3% and 20.4%, respectively, when

Table 4 Effect of intercropping of some crops with sugar beet on sugar beet net root weight production.

Season	Treatment	Root yield weight (kg/m^2) (Mean) ± SE	% Yield incensement	Yield weight (ton/feddan)
2009/10	Faba bean	8.57a ± 0.23	0.71	35.994
	Maize	8.00a ± 0.12	−5.99	33.600
	Cabbage	5.13b ± 0.19	−39.72	21.546
	Control (sugar beet)	8.51a ± 0.31	0.0	35.742
2010/11	Faba bean	7.33a ± 0.20	2.33	30.786
	Maize	6.83a ± 0.18	−4.74	28.686
	Cabbage	4.63b ± 0.32	−35.43	19.446
	Control (sugar beet)	7.17a ± 0.26	0.0	30.114

In column means followed by same letter are not significantly different at the 5% level by DMRT (1955).

Table 5 Potency of tested compounds in reducing Pegomyia mixta larvae populations on sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate.

Compound	Rate/100 l of water	Season	% Reduction						
			Initial effect%	Residual effect after indicated days				Residual effect average	Grand average
				5	7	10	14		
Biopesticide		2009/10							
Bermectine	40 ml		99.00	100.00	100.00	99.00	98.33	99.33	99.27
Plant oil extracts									
Sour orange	1500 ml		86.29	51.27	36.60	36.11	30.36	38.59	48.13
Acidless orange	1500 ml		00.00	00.00	00.00	00.00	00.00	00.00	00.00
Mineral oil									
Super misrona	1500 ml		91.37	96.11	71.67	52.82	35.36	63.99	69.47
Pesticide									
Fenitrothion	500 ml		99.00	100.00	100.00	98.00	97.00	98.75	98.80
Biopesticide		2010/11							
Bermectine	40 ml		98.00	99.00	99.33	98.00	97.78	98.53	98.42
Plant oil extracts									
Sour orange	1500 ml		89.10	55.51	40.73	36.64	28.97	40.46	50.19
Acidless orange	1500 ml		00.00	00.00	00.00	00.00	00.00	00.00	00.00
Mineral oil									
Super misrona	1500 ml		90.00	96.67	72.53	54.73	37.30	65.31	70.25
Pesticide									
Fenitrothion	500 ml		99.00	100.00	99.00	98.00	96.90	98.48	98.58

compared to yields in the first year. Egonyu et al. (2009) found that sole cropping of sesame is recommended for its high yields than for those from sesame + finger millet intercrop.

Follow-up the potency of compounds

P. mixta larvae

The effect of the tested compounds on *P. mixta* larvae infesting sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate is presented in Table 5. Data revealed that Bermectine and Fenitrothion were the most potent compounds in reducing the population density of *P. mixta* larvae during 2009/10 and 2010/11 seasons, with reduction of 99.27% & 98.42% and 98.80% & 98.58%, respectively. They were followed by super misrona (69.47% & 70.25%) and sour orange oil (48.13% & 50.19%), respectively. Acidless orange oil induced no effect. Radwan et al. (1985) tested Lannate, Karfos, Kelthane, Sumithion and Actellic for controlling *P. mixta* larvae on sugar beet in Menoufia, Egypt. They found that all these insecticides caused a drastic drop in larval population. Bassyouny and Khalafalla (1996) mentioned that Novacron was the most effective insecticide followed by Febronil in controlling the beet leaf miner; *P. mixta* in Egypt. Talha (2001) found that Diazinox 60% EC, and Daizol 60% EC had high activity against *P. mixta* larvae in sugar beet fields.

Shalaby (2001) stated that both Dipel 2X and Biofly were mainly effective as biocide preparations between 72 h and 7-days after application for *P. mixta*. El-Husseini et al. (2008) indicated that *P. huscaani* was not affected by spraying conidiospores of *Beauveria bassiana* and poorly affected by dusting such conidiospores. They indicated that the larvae mine the leaves in closed tunnels and thus are protected from both sprayed and dusted conidiopores of *B. bassiana*.

Cassida vittata larvae

The data in Table 6 show that the fenitrothion and Bermectine were the most potent compounds in reducing the population density of *C. vittata* larvae during the two seasons, with reduction >95%. The other tested compounds showed suitable residual effect, as they reduced the population with reduction

Table 6 Potency of tested compounds in reducing Cassida vittata larvae populations on sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate.

Compound	Rate/100 l of water	Season	Number pre-treatment /10 plants	% Reduction							
				Initial effect%	Residual effect after indicated days					Residual effect average	Grand average
					3	5	7	10	14		
Biopesticide		2009/10									
Bermectine	40 ml		137.00	98.69	100.00	100.00	99.00	98.00	89.42	97.28	97.52
Plant oil extracts											
Sour orange	1500 ml		67.00	95.54	95.54	90.64	96.74	94.15	78.29	91.07	91.82
Acidless orange	1500 ml		60.00	97.02	100.00	94.82	95.61	92.74	75.86	91.81	92.68
Mineral oil											
Super misrona	1500 ml		57.00	96.84	100.00	100.00	99.00	98.00	83.53	96.11	96.23
Pesticide											
Fenitrothion	500 ml		137.00	99.79	100.00	100.00	99.00	98.00	93.14	98.03	98.32
Untreated*	–		84.00	94.00	112.00	107.00	64.00	57.00	35.00	–	–
Biopesticide		2010/11									
Bermectine	40 ml		105.00	98.83	99.00	99.00	98.00	95.00	90.06	96.21	96.65
Plant oil extracts											
Sour orange	1500 ml		175.00	95.02	95.77	87.07	96.23	94.03	79.13	90.45	91.21
Acidless orange	1500 ml		84.00	97.35	98.00	95.26	95.89	93.53	77.39	92.01	92.90
Mineral oil											
Super misrona	1500 ml		77.00	97.08	98.00	97.00	96.00	92.80	82.48	93.26	93.89
Pesticide											
Fenitrothion	500 ml		70.00	99.83	99.00	99.00	98.00	94.00	94.39	96.88	97.37
Untreated*	–		175.00	119.00	140.00	133.00	77.00	70.00	42.00	–	–

* Numbers.

Table 7 Potency of tested compounds in reducing predator populations on sugar beet plants at El-Riad district, Kafr El-Sheikh Governorate.

Compound	Rate/100 l of water	Season	Number pre-treatment/ 10 plants	% Reduction							
				Initial effect%	Residual effect after indicated days					Residual effect average	Grand average
					3	5	7	10	14		
Biopesticide		2009/10									
Bermectine	40 ml		14.00	18.18	33.33	16.26	15.50	7.14	00.00	13.45	14.57
Plant oil extracts											
Sour orange	1500 ml		13.00	00.00	13.85	9.82	5.77	00.00	00.00	5.89	4.91
Acidless orange	1500 ml		9.00	00.00	6.67	13.16	2.78	00.00	00.00	4.52	3.77
Mineral oil											
Super misrona	1500 ml		10.00	10.91	25.33	21.84	00.00	10.00	00.00	11.43	11.35
Pesticide											
Fenitrothion	500 ml		11.33	66.30	83.52	65.51	53.66	38.22	00.00	53.35	55.51
Untreated*	–		14.00	11.00	15.00	14.33	16.00	14.00	25.86	–	–
Biopesticide		2010/11									
Bermectine	40 ml		13.00	26.76	29.50	18.37	12.11	5.35	00.00	13.07	15.35
Plant oil extracts											
Sour orange	1500 ml		11.33	00.00	11.76	6.34	00.00	0.45	00.00	3.71	3.09
Acidless orange	1500 ml		12.00	00.00	9.74	4.77	00.00	6.01	00.00	4.10	3.42
Mineral oil											
Super misrona	1500 ml		17.00	00.00	21.59	13.57	15.99	15.56	00.00	13.34	11.12
Pesticide											
Fenitrothion	500 ml		15.00	68.26	83.34	72.79	55.57	31.64	17.06	52.08	54.78
Untreated*	–		13.33	14.00	16.00	16.33	14.00	13.00	15.00	–	–

Where predator: *Chrysoperla carnea*, *Paederus alfierii*, Scymnus spp. and true spiders.
* Numbers.

>90%. El-Sebae et al. (1987) in Egypt reported that organophosphorus compounds like Reldan, Selecron and Tamaron gave nearly complete reduction against *C. vittata* for 15 days after treatment. El-Khouly (1998) found that Marshal and Selecron at rates of 600 g/fed. and 750 ml/fed. gave 95.90% and 94.13% mortality, respectively after 13 days against *C. vittata*

immature. Abo El-Naga (2004) at Kafr El-Sheikh found that Selecron was the most effective insecticide followed by Marshal as they induced high initial and long residual effect against both adults and larvae of *C. vittata* in sugar beet fields. Shaheen et al. (2011) found that Selecron and Marshal were the most efficient compounds against larvae and adults of *C. vittata*. However, Radiant demonstrated a moderate toxic effect in sugar beet plants in Sharkia Governorate.

El-Khouly (1998) indicated that the application of *Bacillus thuringiensis* preparations reduced the infestation by *C. vittata*. El-Husseini et al. (2008) showed that insects that spent most of the time at the lower surface of the sugar beet leaves were poorly affected with spraying conidiospores *B. bassiana* but highly reduced in case of dusting for *C. vittata*.

Side toxic effects of tested compounds on predators inhabiting sugar beet plantations

The data pertaining to predators are presented in Table 7. Fenitrothion was the highest harmful compound against predators (*C. carnea*, *P. alfierii*, Scymnus spp. and true spiders), reducing their numbers during 2009/10 and 2010/11 seasons, by 55.51% and 54.78%, respectively. Bermectine was of moderate effect (14.57% & 15.35%) followed by super misrona (11.35% & 11.12%) in 2009/10 and 2010/11, respectively. Sour orange oil and acidless orange oil had slight effects in this respect.

The present results are in agreement with the findings of Rizk et al. (1999), Saied et al. (2002) and Sharaf et al. (2003). Omar et al. (2001) found that the most harmful insecticide on *C. undecimpunctata* L., *C. carnea* Step. and *O. albidipennis* Reut. was malathion which significantly reduced the numbers of predators especially in plots treated three times on squash plants. El Fakharany (2005) found that fenitrothion was the most harmful on predators; *Scymmus* spp., *C. undecimpunctata*, *Orius* sp., *S. corollae* and true spiders. Kz oil was of a moderate effect, while sour orange oil and acidless orange oil were the safest tested compounds on all predators on watermelon and pepper plants. El Fakharany (2010) found that Marshal induced moderate effect while Bermectine exhibited a slight effect against *C. carnea* and true spiders on cabbage plants.

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